DOCUMENT RESUME

ED 057 553 EC 040 892

AUTHOR	Cotter, Vance W.; Spradlin, Joseph E.
TITLE	Effects of Contingent Music on Retarded Childrens' Performance on Addition Problems. Final Report.
INSTITUTION	Kansas Univ., Lawrence. Bureau of Child Research.; Parsons State Hospital and Training Center, Kans.
SPONS AGENCY	Bureau of Education for the Handicapped (DHEW/OE), Washington, D.C.
BUREAU NO	BR-26-2211
PUB DATE	May 71
GRANT	OEG-0-70-1198(607)
NOTE	36p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Academic Achievement; *Exceptional Child Research; Mathematics; *Mentally Handicapped; *Music; Performance Factors; *Positive Reinforcement

ABSTRACT

In the first of three studies, A Nonverbal Technique for Studying Music Preference, a free operant technique was used for determining the type of music most preferred, and therefore most likely to function as a reinforcer, for 66 retarded children (ages 9-20, IQ range 34-69). In the second study, Effects of Noncontingent Music on Addition Performance, baseline rate of addition computation was determined over four sessions for 38 retarded children (ages 8-18, IQ 35-89). During each session 5-minute periods of preferred music alternated with 5 minutes of silence. Performance was better during silence than during noncontingent music for the majority (27) of the subjects. In the third study, Effects of Contingent Music on Retarded Children's Performance of Addition Computations, during the contingent music sessions preferred music was obtained for a subject's predetermined media inter-response time when the key associated with the correct answer to a machine-produced addition problem was pressed. Control conditions in three experiments were silence, noncontingent music, and contingent white noise. Results showed greater increase in computation rates per session during contingent music than during control sessions. (KW)

ED057553

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

EC
OE-BEH
Project 26-2211

FINAL REPORT

Project No. #26-2211

Grant No. OEG-0-70-1198 (607)

RECEIVED
FEB 1 1972
CEC ERIC

EFFECTS OF CONTINGENT MUSIC ON RETARDED CHILDRENS' PERFORMANCE ON ADDITION PROBLEMS

Vance W. Cotter and Joseph E. Spradlin
Bureau of Child Research, University of Kansas
Parsons Research Center
Parsons State Hospital and Training Center
Parsons, Kansas 67357

May 1971

Department of Health, Education, and Welfare

U. S. Office of Education
Bureau of Education for the Handicapped

EC 040 892E

FINAL REPORT

Project No. #26-2211

Grant No. OEG-0-70-1198 (607)

EFFECTS OF CONTINGENT MUSIC ON RETARDED CHILDRENS' PERFORMANCE ON ADDITION PROBLEMS

Vance W. Cotter and Joseph E. Spradlin
Bureau of Child Research, University of Kansas
Parsons Research Center
Parsons State Hospital and Training Center
Parsons, Kansas 67357

The research reported herein was performed pursuant to a grant with the Bureau of Education for the Handicapped, U. S. Office of Education, Department of Health, Education, and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official position of the Bureau of Education for the Handicapped.

Department of Health, Education, and Welfare

U. S. Office of Education
Bureau of Education for the Handicapped

TABLE OF CONTENTS

Abstract 1

A Nonverbal Technique for Studying Music Preference 2

Abstract 11

Effects of Noncontingent Music on Addition Performance 12

Abstract 20

Effects of Contingent Music on Retarded Children's Performance of Addition Computations 21

A Nonverbal Technique for Studying Music Preference*

Vance W. Cotter and Joseph E. Spradlin
Bureau of Child Research, University of Kansas

Abstract

This study demonstrated a reliable technique for evaluating listening preferences for music. It evaluated simultaneously the relative percentage of time that retarded subjects pressed one of four keys resulting in two types of music, white noise, and silence (no consequence). Although each type of auditory stimulus was continually available, the key which produced a specific type of auditory stimulus was switched each 2 min. A key-press operated a microswitch and resulted in presentation of a stimulus type for the duration of time that the key was pressed. This procedure was used to assess preference for 66 subjects in four 20-min sessions. The results indicated that all 66 subjects preferred music over white noise and silence during each session. Also, 59 of 66 subjects preferred one type of music (Motown Sound) over the other type of music (Doc Severinsen). Fifty-one of 66 subjects preferred Motown Sound music during each of four sessions. There was a trend for differences to increase between preference for Motown Sound Music and the three other stimulus types over four sessions.

This article has been submitted for publication in the Journal of Experimental Child Psychology, and is in press.

*The research was conducted at the Parsons Research Center, Parsons State Hospital and Training Center, Parsons, Kansas.

A Nonverbal Technique for Studying Music Preference

Vance W. Cotter and Joseph E. Spradlin

Music is important to human beings. All cultures have some form of music, and within our own culture, it is related to overall economic development and societal functions (1969). Even though music is important to human behavior there have been relatively few intensive studies of its effects on behavior. There are reports that music influences behavior--resulting from effects described as stimulative and sedative (Schneider, 1955; Zimny & Weidenfeller, 1962). However, only recently have investigators acknowledged that music may function as a reinforcer. Jeffry (1955) found that children pressed a button resulting in 10 sec of uninterrupted music. Barrett (1962) demonstrated that tics of a middle aged man decreased when each tic resulted in brief interruptions of music. Cotter (1969) found that retarded girls increased production of a simulated workshop task when each task resulted in 15 sec of uninterrupted music. These studies demonstrate that music has reinforcing effects; however, they do not demonstrate that these effects of music exceed those of nonmusical stimuli; nor do they demonstrate that the reinforcing effects of one type of music may exceed those of a different type of music.

One approach to the study of the reinforcing effects of music is to determine the type of music that a person prefers over other types, or whether a person prefers music as compared to no-music. One procedure for studying preference is to have the subject indicate, in verbal or written form, whether different types of music are pleasant or unpleasant (Washburn, Child & Abel, 1927); from this, one infers that two or more types of music may have differential reinforcing effects--that one type of music may have reinforcing effects that exceed other types. However, this procedure is undesirable for several reasons. The subject is required to listen to several musical selections for the duration of each selection consuming relatively long periods of time; this suggests inadequate use and conservation of time. Furthermore, even though a person may say that he likes or prefers one type of music over another type, Morgan and Lindsley (1966) found that verbal preference for one type of music over another did not always reliably indicate actual listening behavior. While four normal adult subjects said they preferred stereophonic over monophonic music, only two subjects responded differentially on buttons resulting in stereophonic music. Moreover, even though verbal and written reports may sometimes indicate actual listening behavior, great numbers of persons do not respond because of developmental or organic reasons. For example, preschool children may not read, write, or understand verbal instructions; other children may have similar problems--children who are mentally retarded, speech handicapped, visually, and orthopedically handicapped. Lovitt (1969) used a reliable nonverbal technique with two retarded children to assess preference for one of two types of music--

distinct preferences were demonstrated. Cotter and Toombs (1966) developed a nonverbal procedure to evaluate listening behavior of retardates and found relative preference for several types of auditory stimuli simultaneously. The present research reports additional data and it evaluates the efficacy of this technique for evaluating listening behavior and for studying music preference among retarded children. Specifically, this study evaluates the preference for music as compared to silence, the preference for music as compared to white noise, and the preferences for two types of music.

Method

Subjects

The subjects were 66 retarded children and adolescents at the Parsons State Hospital and Training Center. The CA mean was 14 (range = 9.5 to 20.6); the MA mean was 7.35 (range = 3 to 10.75); and the IQ mean was 57.2 (range = 34 to 69). All subjects were assessed bilaterally via puretone procedures for octave frequencies 250 to 8000 Hz and were found to have a 500 to 2000 Hz average of 30 dB (ISO, 1964) or better, for the better ear.

Apparatus

The experiment was conducted in two rooms. The subject's room, a sound-attenuated IAC room, contained a table, chair, headphones, and a plexiglas keyboard (see Fig. 1). Each of four keys on the keyboard operated a microswitch. All four keys were lighted during the session; termination of the session was signalled by turning off these lights. Three stereophonic tape recorder-players and electromechanical equipment used to program auditory stimuli and record data were housed in an adjacent room.

During the session a key-press on each of the three keys resulted in presentation of a specific type of auditory stimulus. A key-press on a fourth key obtained no programed consequence of sound; i.e., no change over not depressing the key. In order to eliminate the possibility of obtaining a spurious result due to position responses, the stimulus condition associated with each of the four keys was switched every 2 min during the session. Therefore, if a key press obtained one type of music initially, it changed to one of the other three alternative conditions after 2 min. If the subject pressed more than one key simultaneously or if he did not respond, no auditory stimulus was presented.

The three types of auditory stimuli were: (1) "The Motown Sound" (MTC 655), a stereophonic tape recording of 16 different selections of songs described as the sound of Young America--both vocal and instrumental media were used on all selections; (2) "Tempestuous Trumpet Doc Severinsen and His Orchestra" (Command RS 4T 819), a stereophonic recording of 12 selections that had been composed within the past 50 years--only instrumental media were used; and (3) tape recorded white noise. During the

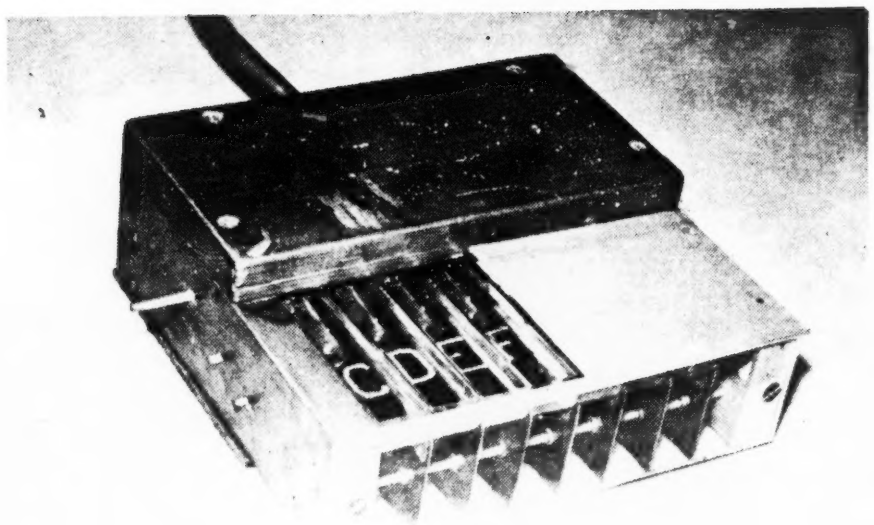

Fig. 1. Picture of plexiglas keyboard used to evaluate simultaneously the relative percentage of time spent for two types of music--white noise and silence (no consequence). Every two minutes each type of auditory stimulus was associated with a different key; a key-press operated the microswitch and resulted in presentation of a stimulus type for the duration of time (number of sec) that the key was depressed.

session, the three tape recorders were constantly in motion; the two music tapes were recorded so that one musical selection immediately followed the previous one. This eliminated the usual short pauses between songs that occur on commercial tape recordings.

Procedure

Each subject was seen for four 20-min sessions on consecutive days. The subject was brought into the experimental room and seated; he was told that when the key lights were on and when he put on the headphones, he could listen to different types of sound for as long as he pressed down

on any one of the four keys (the experimenter demonstrated this by briefly pressing down on each key while the subject wore the headphones). When the key lights went off, it would be time to leave the room. The experimenter then left the room and no further instructions were given.

The data recorded was the number of seconds that the subject pressed the key associated with each of the four stimulus conditions--Motown Sound, Tempestuous Trumpet, white noise, and no programed consequence.

Results

Music vs. Silence

All subjects depressed keys resulting in music for over 50% of the total sessions' time; i.e., amount of time depressing keys resulting in music surpassed the amount of time either not pressing any key, pressing the key resulting in white noise, or pressing the key resulting in no programed consequence.

Music vs White Noise

All subjects depressed the keys resulting in one of the two types of music for a greater percentage of time than they pressed the keys resulting in white noise. So mere presentation of a nonmusical stimulus was not equivalent to presentation of music.

Motown Sound vs Tempestuous Trumpet

Fifty-nine of 66 subjects responded a greater percentage of the time on the key resulting in Motown Sound than on the key resulting in Tempestuous Trumpet music; seven subjects pressed the key resulting in Tempestuous Trumpet for a larger percentage of time than for Motown Sound.

Time Committed to Music

The median percentage of time committed to music out of the total time during the four sessions was 90%. No subject spent less than 51% of the time pressing keys resulting in music.

Stability of Preference

Fifty-one of 66 subjects pressed the key resulting in Motown Sound for more time than any other key during each of the four sessions. This means that there was no cross-over in preference during each of the four sessions for these subjects. Two subjects pressed the key resulting in selections from Tempestuous Trumpet for more time than they pressed any other key for each of the four sessions.

Figure 2 gives 16 frequency distributions that indicate the number of subjects who spent a specified amount of time listening to each of the four auditory stimuli during the four sessions. The bottom row of the four histograms indicates that none of the 66 subjects spent more than 2 min during any session pressing the key resulting in no consequence or change in auditory stimulus. The four histograms labelled white noise show that 63 out of 66 subjects spent no more than 2 min pressing the key resulting in white noise during any of the four sessions; however, one subject did spend 12 min listening to white noise during the second session. The four histograms labelled Tempestuous Trumpet show that none of the 66 subjects ever spent more than 14 min during any session listening to this type of music. Moreover, the histograms indicate that as the sessions progressed, this type of music was preferred less of the time. For example, in the first session 31 of 66 subjects spent 2 min or less listening to Tempestuous Trumpet music. In comparison, the fourth session shows that 45 of 66 subjects spent 2 min or less listening to this music. The four histograms labelled Motown Sound indicate that as sessions progressed, this type of music was preferred more of the time during each session by a greater number of subjects. In Session 1, 13 of 66 subjects listened to Motown Music at least 18 to 20 min. In comparison, the fourth session shows that 35 of 66 subjects listened to this type of music at least 18 of 20 min. Moreover, the number of subjects that listened to Motown Sound from 16 to 20 min during the first session (34 subjects) increased to 51 subjects in the fourth session.

Figure 3 shows the duration of time that eight subjects pressed keys resulting in Motown Sound, Tempestuous Trumpet, white noise, no consequence, and total music over four sessions. The top four graphs (Subjects 35, 22, 32, and 28) represent individual performances of 51 of the 66 subjects; i.e., they show a strong preference for Motown Sound with no cross-over in preference over each of the four sessions. Also, there was a trend for differences to increase between the number of seconds spent on Motown Sound and the number spent on the three other stimulus types over the four sessions.

The bottom four graphs (Subjects 12, 26, 31, and 13) represent the performance of the relatively atypical individuals. The graph for subject 12 is representative of the two subjects who showed a consistent preference for the Tempestuous Trumpet music; i.e., there was consistent preference with no cross-over for each of the four sessions. However, the number of seconds spent pressing the key was less in comparison to time spent by those subjects preferring Motown Sound. The performance of subject 26 demonstrates strong preference for music over no consequence or white noise--it is representative of three subjects who showed change or cross-over for two of four sessions. There was no strong preference for either type of music. Subject 31 showed no preference among white noise, Motown Sound, and Tempestuous Trumpet for three sessions. During the fourth session, there

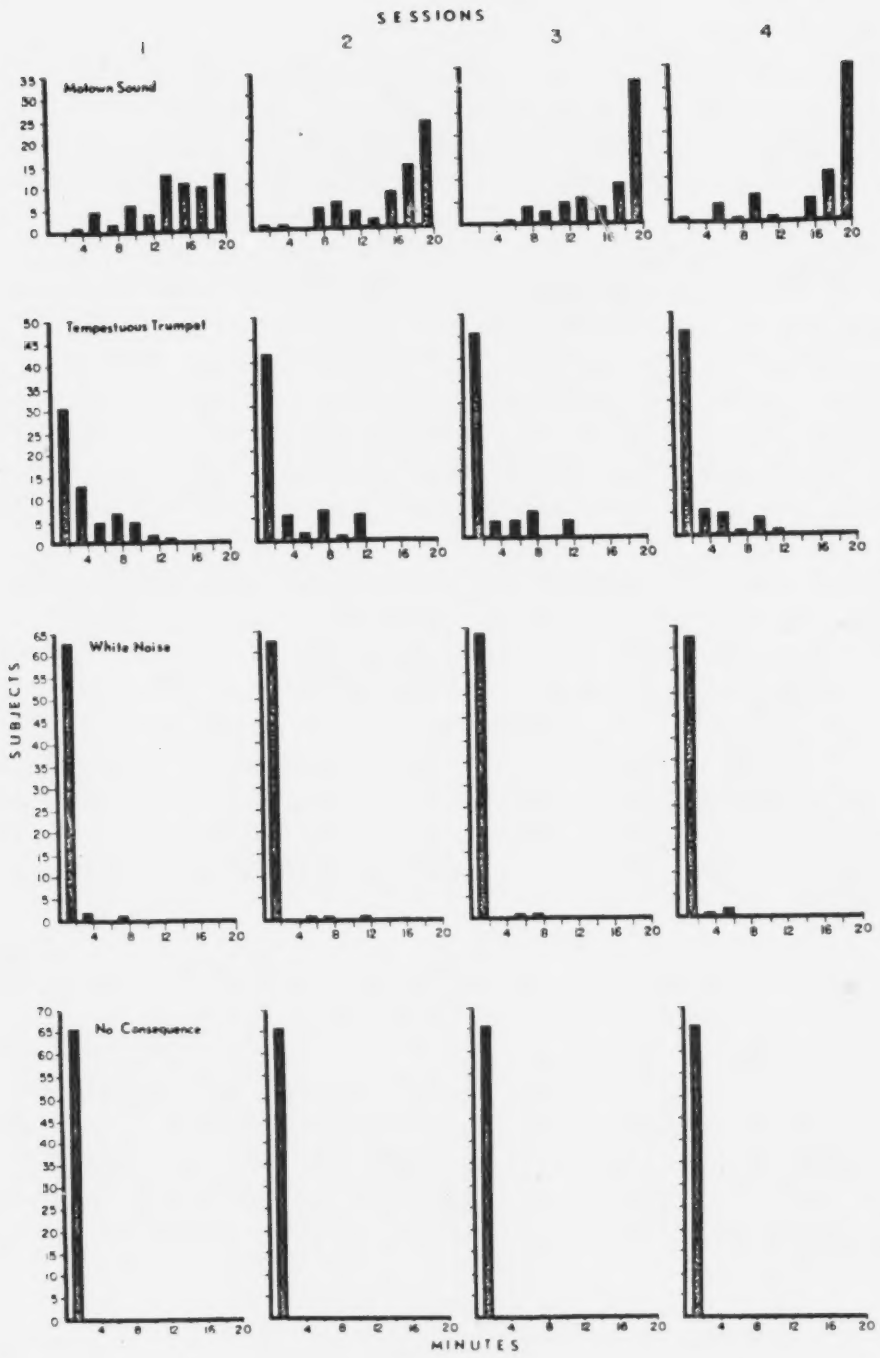

Fig. 2. Histograms of 16 frequency distributions showing the relative duration of time (min) that 66 subjects pressed the key resulting in Motown Sound. Tempestuous Trumpet, White noise, and No Consequence (silence) during each of four 20-min sessions.

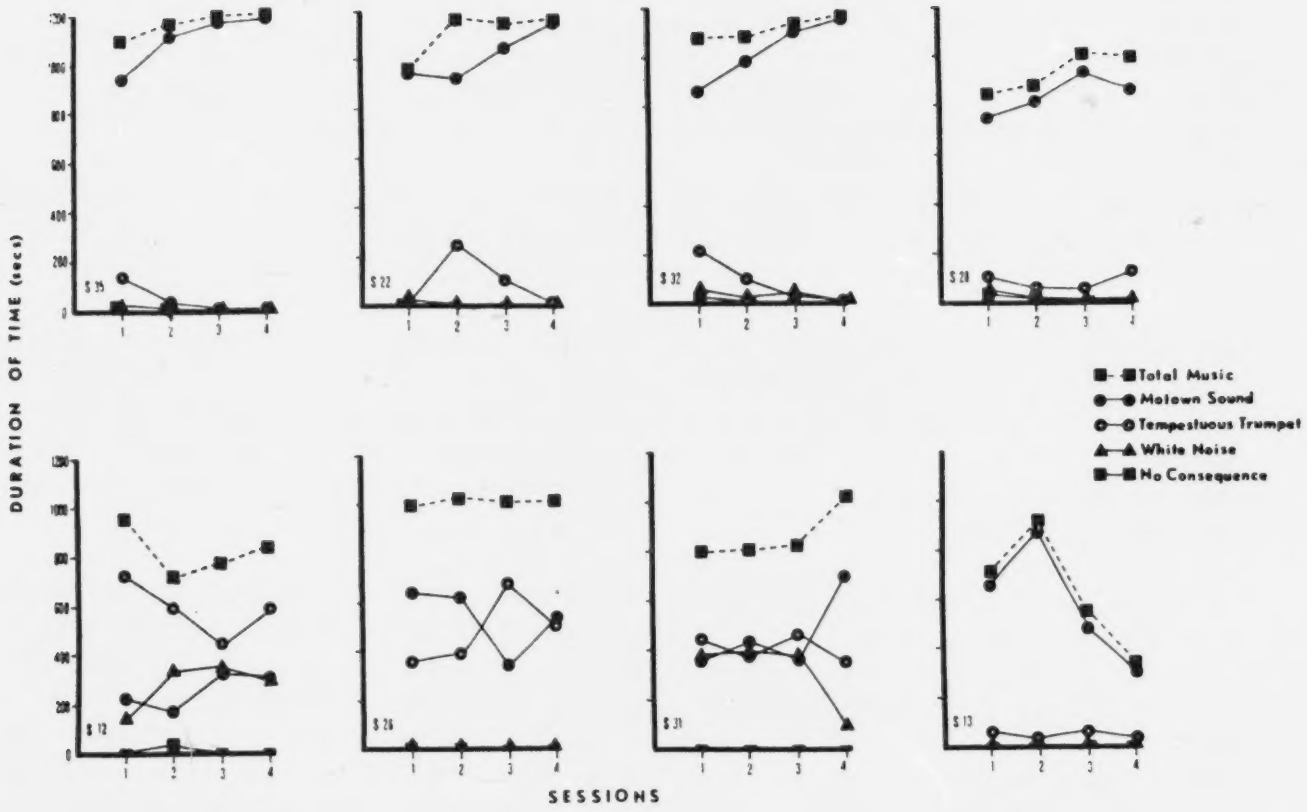

Fig. 3. Representative graphs showing the relative duration of time (sec) that eight subjects pressed the key resulting in Total Music, Motown Sound, Tempestuous Trumpet, White Noise, and No Consequence during each of four sessions. The top four graphs represent the listening preferences of 51 of 66 subjects; the bottom four graphs represent preference profiles that were atypical in the group.

was an increase in number of seconds spent for Motown Sound as compared to either of the two other types of auditory stimuli. Subject 13 preferred the Motown Sound over other stimuli, but the amount of time spent pressing the key was relatively low and decreased over sessions.

Discussion

The data presented in the Results section indicate that the nonverbal technique used was reliable for evaluating the listening behavior for certain types of music and other types of auditory stimuli. Reliability was so great that 51 of 66 subjects showed no cross-over in preference in any of four sessions. This indicates that one 20-min session would give a good estimate of relative preference among the four auditory stimuli.

The development of such an efficient and reliable technique suggests research in two areas. The first area of research would investigate the relative effects of preferred and nonpreferred music when presented contingently on a typical repetitive operant response. If music with different preference values resulted in different response rates when presented contingently, the preference technique should prove useful in selecting music to be presented in such behavior modification studies as described by Barrett (1962). Music has certain advantages over other reinforcers. It can be presented and withdrawn immediately. This, of course, is not true of candy, trinkets, or tokens.

Secondly, the technique provides an effective method for investigating the factors which effect music preference. For example, it is now feasible to analyze the differential effects of intensity, frequency, and timbre (quality) on the preferential response. It would also be possible to determine the limits of preference stability over time. Perhaps some music has high preference values initially but diminishes over time, while other music has moderate or low preference values initially but increases over time.

References

Barrett, B. H. Reduction in rate of multiple tics by free operant conditioning methods. Journal of Nervous and Mental Disease, 1962, 135, 187-195.

Cotter, V. W. Effects of music on mentally retarded girls' performance of manual tasks. Dissertation Abstracts B, 1969.

Cotter, V. W., & Toombs, S. A procedure for determining the music preferences of mental retardates. Journal of Music Therapy, 1966, 3, 57-64.

Jeffry, W. E. A new technique for motivating and reinforcing children. Science, 1955, 121, 371.

Lovitt, T. Free operant assessment of musical preference. Journal of Experimental Child Psychology, 1968, 65, 361-367.

Morgan, B. M., & Lindsley, O. R. Operant preference for stereophonic over monophonic music. Journal of Music Therapy, 1966, 3, 135-143.

Schneider, E. H. Relationships between musical experiences and certain aspects of cerebral palsied children's performance on selected tasks. In E. T. Gaston (Ed.), Music therapy. Lawrence, Kansas: Allen Press, 1955, Pp. 250-277.

Statistical Abstract of the United States 90th Annual Edition. U. S. Bureau of Census, Washington, D. C., 1969.

Washburn, M. F., Child, M. A., & Abel, T. M. The effects of immediate repetition on the pleasantness or unpleasantness of music. In M. Schoen (Ed.), The effects of music. New York: Harcourt, Brace & Jovanovich, Inc., 1927.

Zimny, G. H., & Weidenfeller, E. W. Effects of music on GSR of children. Child Development, 1962, 33, 891-896.

Effects of Noncontingent Music on Addition Performance

Vance W. Cotter and Joseph E. Spradlin
Bureau of Child Research, University of Kansas

Abstract

This study evaluated the effects of noncontingent preferred music on rate and accuracy of addition computation. A match-to-sample apparatus presented addition computations and four multiple-choice answers. Noncontingent music was presented to each of 38 retarded subjects via headphones for four sessions. During each session 5-minute periods of preferred music were alternated with 5-minute periods of silence. Data collected were the number of correct computations and number of errors during music and silence. Analysis indicated significantly better performance during silence compared to noncontingent music across the four sessions. Twenty-seven subjects solved more addition problems during silence than during music; ten subjects solved more problems during music; and one worked the same number of problems during silence as during music.

Effects of Noncontingent Music on Addition Performance

Vance W. Cotter and Joseph E. Spradlin

Music can reinforce behavior as in Barrett's (1962) reduction of tics via contingent music presentation, and as in Jeffry's (1955) study where children pressed a button to obtain 10 secs of uninterrupted music. Recently, Cotter (1969) found that retarded girls increased production of a simulated workshop task during periods when each task obtained 15 secs of uninterrupted music as compared to silence periods.

While certain music may have reinforcing effects when presented contingent on responses, it may control specific verbal and motor responses that interfere with academic performance when presented noncontingently. For example, Zimney and Weidenfeller (1962) using the GSR as a measure, found that certain types of music presented noncontingently "calmed" children while other types "excited" them. Furthermore, when Cotter (1969) presented preferred music contingent on work-task responses, he observed that the subjects, while maintaining consistent work performance, also responded by singing and/or by physical movements during the contingent music periods.

The effects of noncontingent music on tasks requiring attention, accuracy, and concentration are vague and difficult to interpret. Studies of industrial uses of music suggest that music may distract a person and result in lower productivity (Kirkpatrick, 1943). Furthermore, they suggest that music may have no effect on performance if a person has developed stability in patterning of work and work tempo (McGehee & Gardner, 1949). However, others believe that music may be beneficial if certain variables concerning music reproduction, style of playing, and selection of music are considered (Reynolds, 1943; Cardinell, 1944; McDaniel, 1945; Muzak Corporation, 1958, 1964). They suggest that music does not distract if intensity is maintained at low levels and selections are unobtrusive.

The literature on the effects of noncontingent music on performance in academic settings is virtually nonexistent. Whether music impedes or enhances academic performance in the classroom is not clear. Certain types of music may motivate children and thus improve the classroom environment and facilitate the learning process; on the other hand, some types of music may disrupt the learning environment. The present study is an initial probe into the effects of the noncontingent presentation of preferred music on addition computation performance. Specifically, this study compares the rate and accuracy of addition computations during periods of music as compared to periods of silence.

Method

Subjects

The subjects were 38 retarded children and adolescents at the Parsons State Hospital and Training Center. The CA mean was 13.7 years (range = 8.4 to 18.6); the MA mean was 9.3 years (range = 8.4 to 10.7); and the IQ mean was 57.9 (range = 35 to 89). All subjects were assessed bilaterally via puretone procedures for frequencies 500, 1000, 1500, and 2000 Hz and had an average threshold for those frequencies of 30 dB (ISO, 1964) or better, for the better ear. The subjects were assessed individually for addition computation level and all were found to solve at least 9 out of 20 two-numeral addition problems. Music preference assessment via the Cotter and Spradlin (in press) procedure revealed that all subjects preferred music over white noise and silence.

Apparatus

The experiment was conducted in two rooms. The subject's room contained a four-choice match-to-sample apparatus, a table, chair, headphones, and pencil and paper (Fig. 1). The match-to-sample stimuli were presented on 35 mm slides via rear view projection. The sample stimulus was an addition problem consisting of two, three, four, or five arabic numerals in a single column presented on the upper window (25 x 11 cm). Each of the four-choice stimuli consisted of one or two numerals presented on the four lower (hinged) windows (5.5 x 5.5 cm each); the correct answer appeared on only one of these windows.

The subject's response was to press one of the lower windows. If he pressed the correct key, a different problem was presented in .9 sec. If a wrong key was pressed, he was presented the same problem after a 3 sec black-out period. A different problem was presented only after the subject pressed the correct key. This was controlled automatically via electro-mechanical equipment located in the second room; each subject's correct and incorrect responses were recorded cumulatively on digital counters.

During each 20-minute experimental session, the subject received music via headphones for five-minute periods alternated with five-minute silence periods; the sequence of music and silence periods was reversed daily for four sessions. This was controlled via the tape recorder-player in conjunction with programming equipment.

"Motown Sound" (MTC 655), a stereophonic tape recording of 16 different selections of vocal and instrumental songs described as "The Sound of Young America," was presented during the music periods. The subjects of this study had previously demonstrated a preference for this music over straight instrumental music. During the session, the tape recorder was constantly in motion; the tape was recorded so that one

Figure 1. Picture of match-to-sample apparatus used to present addition computations and four multiple-choice answers via rear-view carousel projection. Auditory stimuli were presented through earphones.

musical selection immediately followed the previous one. This eliminated the short pauses between songs usually occurring on commercial tape recordings. The intensity level during the five-minute music periods ranged from 68 to 78 dB.

Pretest of Addition Computation Levels

Each subject was given a pretest examination to determine his individual level of competence in addition computation. The pretest consisted of 80 addition problems. There were 20 problems consisting of single columns of two numerals; then in rank order he was given the same number of three, four, and five numeral problems. The criterion for setting addition computation levels was the highest column level at which he solved at least 9 of the 20 problems.

During the pretest, each subject was brought into the experimental room, seated in front of the match-to-sample apparatus, and given instructions: "I want you to work some addition problems on this machine. This is an addition problem (E pointed to the problem on the upper window). and the answer is on one of these windows (E pointed to each of the lower windows). You are to look at the problem, add the numbers then find the window that has the correct answer. When you push the correct answer, the machine will give you a different problem to work. If you push the wrong answer, the lights on the machine will go out for a while and then come on with the same problem for you to work correctly. If you want, you can use this pencil and paper to help you add." Then E demonstrated pressing a correct answer and an incorrect answer, and said, "Now you work as many problems as you can and I am going to leave the room. You can start when this light goes on and stop when it goes off." Then E left the room.

Procedure

Each subject attempted to add problems taken from the numerical level at which he had met criterion during the addition pretest. During each of four 20-minute sessions the subject attempted to work 81 problems. If he completed the problems before the session ended, he was presented the same problems for the remaining session time. In the first session each subject was given the headphones and told: "Today, I want you to wear these headphones while you are working the addition problems. Sometimes you will hear music and sometimes you will not." Then the experimenter placed the headphones on the subject and left. Data recorded were the number of correct and incorrect computations made during the music periods and silence periods for each session.

Results

Two types of data were analyzed--rate of addition computations (number of problems answered correctly) and accuracy $\frac{(\text{correct - errors})}{\text{correct + errors}}$. The analysis of variance for number of correct responses yielded a significant main effect for music vs silence ($p < .001$) and also for sessions ($p < .025$). The sessions times conditions effect was not significant. Figure 2 shows the mean number of correct computations per session during music and silence. As can be seen, more correct responses were made during the silence condition across all four sessions. Moreover, there was an improvement in performance across sessions during both the music and silence conditions.

Inspection of individual performances for the total four-session period revealed that 27 of 38 subjects made more correct responses under silence condition; 10 subjects made more correct responses under the music condition; and one subject performed equally well under the two conditions.

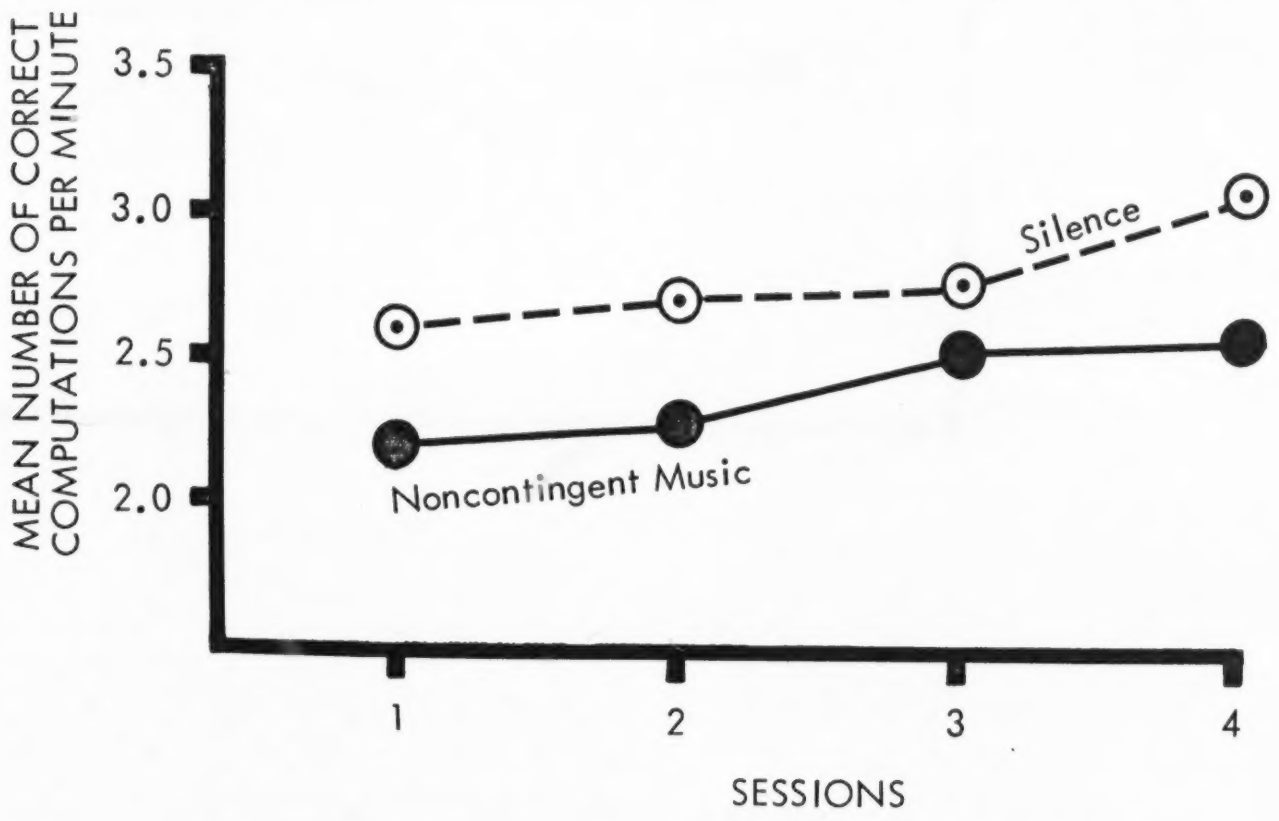

Figure 2. Mean rate of addition computations per minute for 38 subjects during noncontingent music and silence over four sessions. During each session 5-min periods of noncontingent music were alternated with 5-min periods of silence.

The analysis of variance of the accuracy scores also yielded a significant main effect for music vs silence ($p < .05$). Figure 3 shows the mean accuracy scores per session during music and silence; performance was more accurate during silence than during noncontingent music across all four sessions.

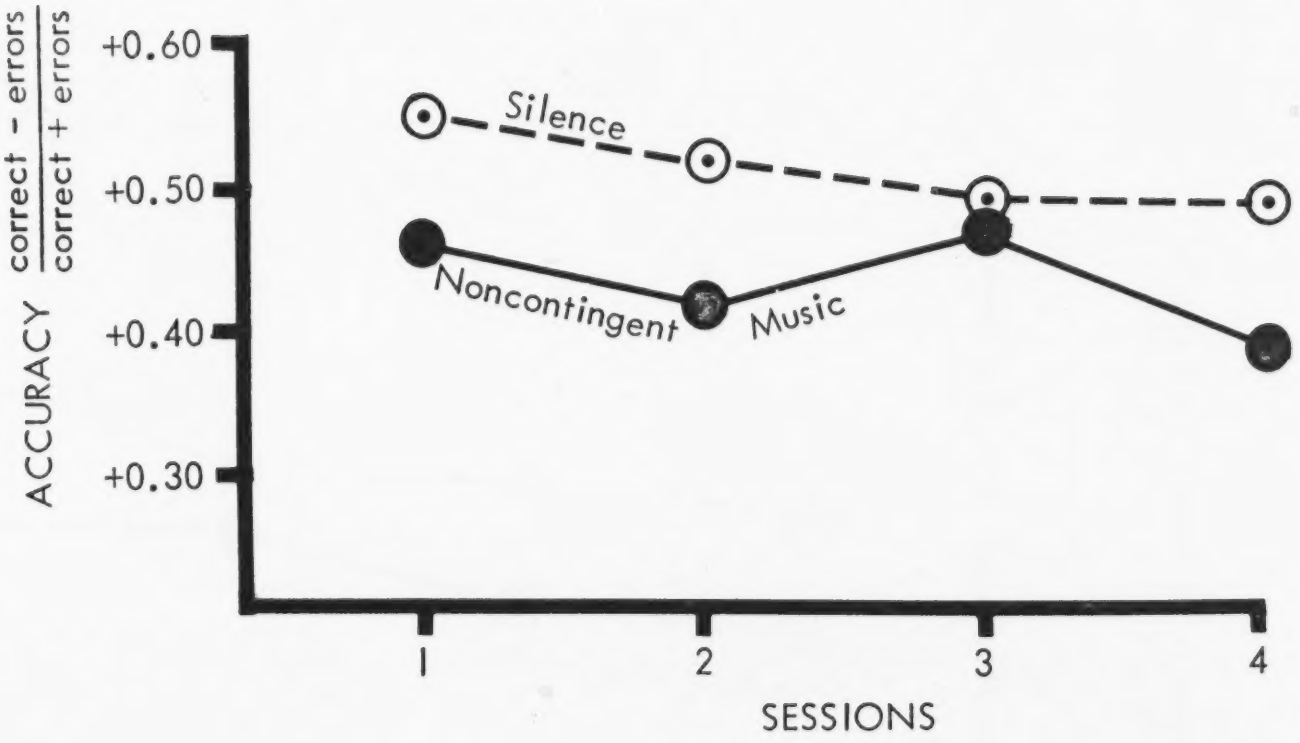

Figure 3. Mean accuracy scores $\left(\frac{\text{correct - error}}{\text{correct + error}}\right)$ for 38 subjects during noncontingent music and silence over four sessions. During each session 5-min periods of noncontingent music were alternated with 5-min periods of silence.

Discussion

Offices and industries have used music increasingly during the past few years. Some of the reasons given for this are increased morale and increased productivity. While schools often use music, it is most frequently confined to a period of time when the students are not engaged in studying. Since certain types of music are a positive reinforcer, it seems likely that its use in school might decrease boredom and, in general, make school a more reinforcing place to be. However, prior to initiating a program using music during study periods, investigation should be made not only concerning its reinforcing properties but also concerning its interfering properties. The present study investigated the use of a preferred type of music. It was reinforcing (highly preferred by the subject) and also a type of music that would likely interfere with academic performance. It was loud and predominantly rhythmical and vocal--a type of music often used at teenage dances.

The data does indicate that most subjects performed less problems and were less accurate during five-minute music periods than during alternate five-minute silence periods. However, the study does not tell us what the overall rate would have been during music alone as compared to what it would have been during silence alone. Children generally study in school under silence conditions. Changes in such constant conditions have been shown to have a temporary effect on behavior (Azrin, 1958). If this is the case, then additional experience in doing academic tasks with music might result in a very different effect. Some children claim that they study better in the home with the stereo playing loudly. Such might be the case. Research by Azrin (1958) showed that noise had a variety of effects on behavior according to when it was presented. Presented noncontingently it interfered with performance initially. Presented contingently on an observing response, it interfered with observing. Turning it off, contingent on responding, increased observing responses. Moreover, Cotter (1969) found that when music was presented contingent on completion of a workshop task, performance was superior to performance under either silence or noncontingent yoked music.

These findings suggest that a contingent schedule of music presentation, in addition to type of music played, may have different effects on academic performance. Investigation of the effects of music on non-machine academic tasks should prove interesting. The task of the present experiment used a teaching machine presentation. Previous experience with the machine has indicated that the children respond at rather high rates and show few of the avoidance responses associated with some other types of academic tasks. The present study does not tell us anything about the child's willingness to enter the study situation under music and silence conditions. Azrin (1958) found that subjects might perform as well under noise conditions as under silence conditions, but that absenteeism was higher under noise conditions.

References

Azrin, N. H. Some effects of noise on human behavior. Journal of Experimental Analysis of Behavior, 1958, 1, 183-200.

Barrett, B. H. Reduction in rate of multiple tics by free operant conditioning methods. Journal of Nervous and Mental Disease, 1962, 135, 187-195.

Cardinell, R. L. Music industry. New York: American Society of Composers, 1944.

Cotter, V. W. Effects of music on mentally retarded girls' performance of manual tasks. Dissertation Abstracts, 1969.

Cotter, V. W., & Spradlin, J. E. A nonverbal technique for studying music preference. Journal of Experimental Child Psychology, in press.

Jeffry, W. E. A new technique for motivating and reinforcing children. Science, 1955, 121, 371.

Kirkpatrick, F. H. Music in industry. Journal of Applied Psychology, 1943, 27, 268-274.

McDaniel, R. How music increases office production. American Business, 1945, 15, 22-26.

McGehee, W., & Gardner, J. E. Music in a complex industrial job. Personnel Psychology, 1949, 2, 405-417.

Muzak Corporation. Effects of Muzak on office personnel. New York: Muzak Corp., 1958.

Muzak Corporation. Effects of Muzak on industrial efficiency. New York: Muzak, Division of Wrather Corp., 1964.

Reynolds, W. Selecting music for the factory. Personnel, 1943, 20, 95-98.

Zimney, G. H., & Weidenfeller, E. W. Effects of music on GSR of children. Child Development, 1962, 33, 891-896.

Effects of Contingent Music on Retarded Children's Performance of Addition Computations

Vance W. Cotter and Joseph E. Spradlin
Bureau of Child Research, University of Kansas

Abstract

This study evaluated the effects of preferred contingent music on rate and accuracy of addition computation. The computation level, music preference, contingent music time interval, and median inter-response time (IRT) was determined individually for 54 retarded subjects. Each subject was randomly assigned to AB or BA treatment conditions of three experiments. In each experiment treatment AB was contingent music for the first 10 sessions and a control condition during the last 10 sessions; treatment BA was a control condition for the first 10 sessions and contingent music during the last 10 sessions. During contingent music sessions, each subject obtained preferred music through earphones after pressing the key associated with the correct answer to a machine-produced addition problem. Each time a correct response obtained music, the duration of music presentation was extended for the number of seconds equal to the subject's predetermined median IRT; however, music was terminated if (a) an error was made, or (b) a correct response was not made within the IRT. The control condition was silence (Experiment 1), noncontingent music (Experiment 2), and contingent white noise (Experiment 3). The results indicated a greater increase in computation rates per session during contingent music than during control sessions. This was true whether contingent music sessions preceded or followed control sessions.

Effects of Contingent Music on Retarded Children's Performance of Addition Computations

Vance W. Cotter and Joseph E. Spradlin

Recent studies have found that when music is presented contingent on specific responses, it can function as a reinforcer. Cotter and Toombs (1966) found that retarded children pressed a key for greater percentages of time to obtain music than either noise or silence (no consequence). Similar results were found with normal children (Jeffry, 1955) and adults (Morgan & Lindsley, 1966). In a clinical study, Barrett (1962) reported reduction of facial tics in a middle-aged man when each tic resulted in brief interruptions of music. More recently, Cotter (1969) evaluated the effects of contingent music and yoked noncontingent music on retarded girls' production of simple repetitive workshop tasks. He found that the number of tasks completed was significantly increased by contingent music over silence; in comparison, subjects receiving yoked noncontingent music did not improve.

Even though contingent music can have reinforcing effects on specific behaviors, it may also elicit certain motor and verbal responses that impede or interfere with the performance of academic tasks. For example, whether preferred music was presented contingent or noncontingent on repetitive work-task responses (Cotter, 1969), subjects also responded by singing and/or physical movements. While contingent music maintained consistent performance of a simple work task, the effects of preferred music might impede performance of a task requiring more attention and concentration.

The literature on the effects of contingent music presentation on academic tasks is virtually nonexistent. However, Azrin's (1958) research indicated that noise had a variety of effects on behavior, depending on when it was presented: noise interfered with observing when presented contingent on an observing response; noise increased observing when the observing response terminated the noise; and it initially interfered with performance when presented noncontingently.

Contingent music may impede or improve academic performance, depending on the schedule of presentation and the type of music. The present study is an initial probe into the effects of contingent music presentation on rate and accuracy of addition computation performance.

Method

Subjects

Fifty-four subjects were selected from a total of 108 subjects at Parsons State Hospital and Training Center on the basis of the following criteria. Subjects had to have an average pure tone threshold better than 30 dB (ISO 1964) for frequencies 500, 1000, 1500, and 2000 Hz. All subjects had to show a preference for music over silence or white noise during each of four 20-minute sessions (Cotter & Spradlin, in press). All subjects had to make at least 9 out of 20 correct responses to addition problems involving at least two numerals. All subjects had to be available for the experiment five days per week. Fifty-four of the subjects were excluded from the study for the following reasons: 7 did not meet criteria for hearing; 2 did not meet the music preference criteria; 15 did not meet the addition criteria, and 30 subjects were unavailable because of daily clinical or experimental scheduling conflicts.

The subjects used in the study ranged in CA from 8.4 to 18.6 yrs. (mean = 13.8; SD = 2.2 yrs); in MA from 3.1 to 10.8 yrs. (mean = 7.4; SD = 1.46); and Stanford Binet IQ scores ranged from 35 to 89 (mean = 57.63; SD = 10.21). The number of months that the subjects had been institutionalized ranged from 3 to 133 mos. (mean = 43.4; SD = 31.8).

Apparatus

The apparatus was housed in two rooms--an experimental and an observation room. A match-to-sample apparatus, a set of earphones, and a pencil and paper (Figure 1) were housed in the experimental room.

The four-choice match-to-sample stimuli were presented on 35 mm slides to the subject via rear view projection. The sample stimulus was an addition problem consisting of either two, three, four, or five arabic numerals in a single column presented on the upper window (Figure 2). Each of the four-choice stimuli consisted of one or two arabic numerals presented on the four lower (hinged) windows. The correct answer appeared on only one of the four windows.

The subject's response was to press one of the lower windows. A correct response resulted in forward operation of the carousel projector so that the next slide moved into view. A press on any other window was incorrect and resulted in a black-out for three seconds; then the same slide was presented until a correct response was made.

The observation room housed standard electromechanical programing/recording equipment and a stereophonic tape recorder-player. This equipment automatically presented the slides, recorded correct and incorrect responses, and it was used to manipulate and control the presentation of auditory stimuli through the earphones.

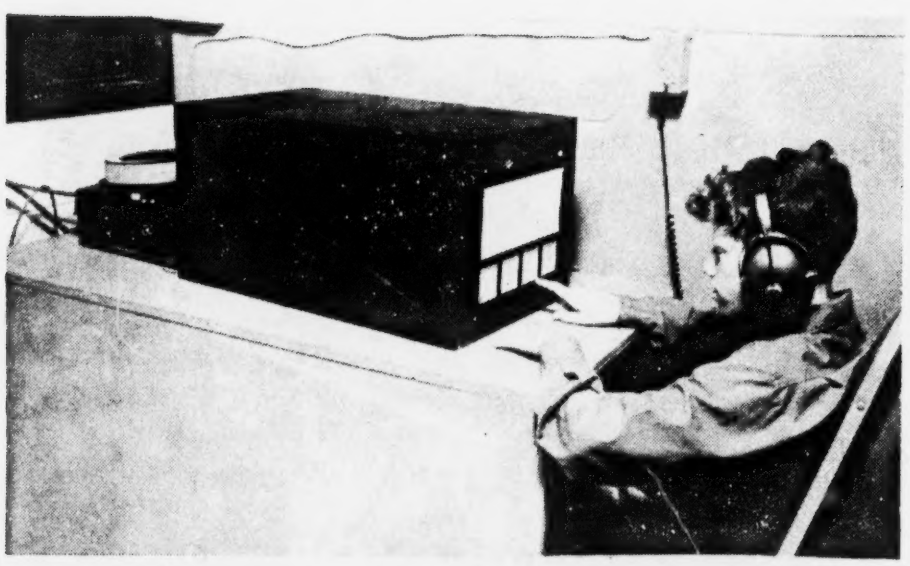

Figure 1. Picture of match-to-sample apparatus used to present addition computations and four multiple-choice answers via rear-view carousel projection. Auditory stimuli were presented through earphones.

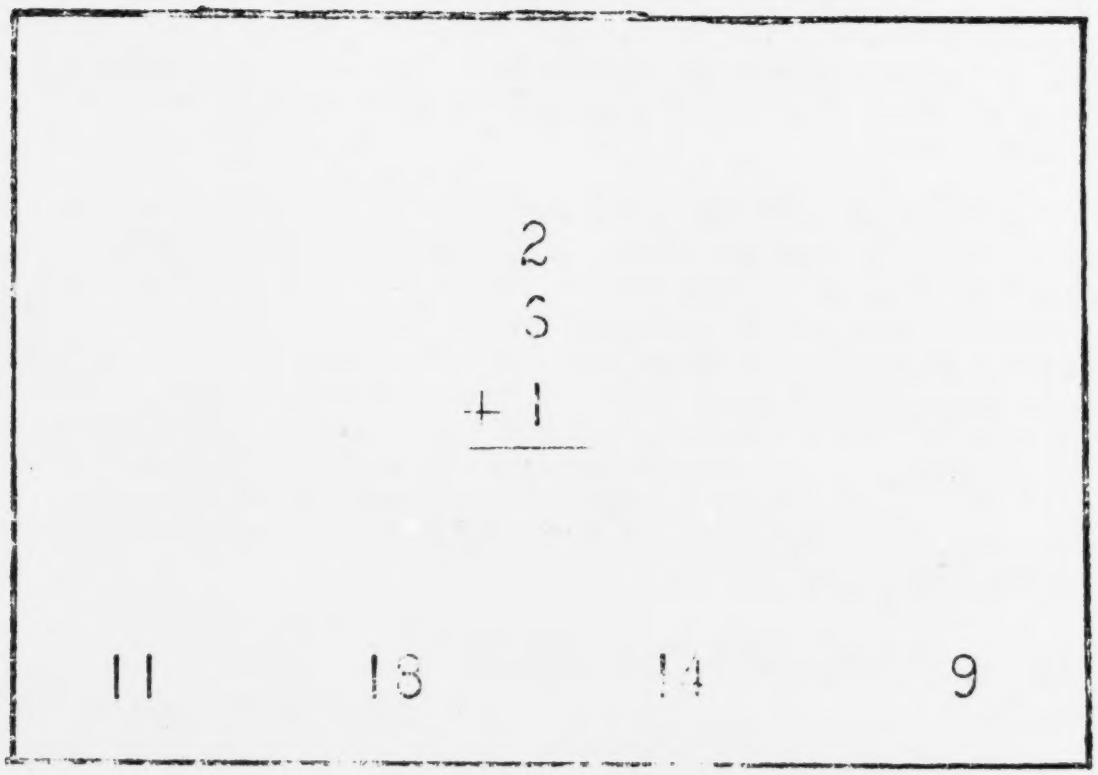

Figure 2. Picture showing a four-choice match-to-sample stimulus presented via a 35 mm slide. This is an example of a three-numeral addition problem presented on the upper portion with four answers presented in the lower portions.

Pre-Experimental Procedures

Setting Addition Computation Levels

Each subject attempted 80 addition computations. There were 20 of the two-numeral computations presented first; then in rank order the same number of three-, four-, and five-numeral computations were presented.

During this session, each subject was brought into the experimental room, seated in front of the match-to-sample apparatus, and given instructions: "I want you to work some addition problems on this machine (E pointed to the problem on the upper window). This is an addition problem and the answer is on one of these windows (E pointed to each of the lower windows). You are to look at the problem, add the numbers, and then find the window that has the correct answer. When you push the correct answer, the machine will give you a different problem to work. If you

push the wrong answer, the lights on the machine will go out for a while and then come on with the same problem for you to work correctly. If you want, you can use this pencil and paper to help you add." Then E demonstrated pressing a correct answer and an incorrect answer, and said, "Now you work as many problems as you can and I am going to leave the room. You can start when this light goes on and stop when it goes off." Then E left the room.

On the basis of the data obtained in this session, each subject was assigned a problem level. A subject's problem level indicated the number of digits, or the column length, of the problems to be presented to that subject under subsequent experimental conditions. Thus, some subjects would be assigned two-numeral column addition problems, some three-numeral, and some four- or five-numeral columns. The highest order of column in which a subject could get at least nine out of 20 correct computations was determined to be that subject's problem level. Thus, if a subject got 12 out of 20 correct on three-numeral column problems, but only 6 out of 20 correct on four-numeral problems, his problem level was set at 3.

Setting the Contingent Music Time Interval

This procedure called for each subject to attempt to add different problems at his assigned problem level. During each of four 20-minute sessions the subject attempted to work 81 problems. If he completed the problems before the session ended he was presented the same problems for the remaining session time. On the first session each subject was given the earphones and told: "Today, I want you to wear these earphones while you are working the machine. Sometimes you will hear music and sometimes you will not." Then the experimenter placed the earphones on the subject and left.

During each session, uninterrupted noncontingent preferred music was presented through the earphones for five minutes alternated with five minutes of silence. The order of presentation of the music and silent periods was reversed daily. The length of time between correct computations or interresponse time (IRT) was recorded for each subject. Subsequently, his median IRT was calculated from measures taken during the last two sessions. This median IRT was to be the length of time that music would be extended for each correct computation during subsequent contingent music conditions.

Experimental Design

The 54 subjects were randomly assigned to each of three experiments designed in a series (N = 18 per experiment). Then within each experiment the 18 subjects were randomly assigned to either treatment AB or BA (N = 9 per treatment). In each experiment, subjects in treatment AB were under the condition of contingent music for the first 10 sessions,

and under the control condition for the last 10 sessions. Subjects in treatment BA were under control conditions for the first 10 sessions and under contingent music conditions during the last 10 sessions. The control condition was different for each experiment. In Experiment I the control was silence; in Experiment II it was noncontingent uninterrupted music; and in Experiment III, it was contingent white noise.

Experiment I

Contingent Music and Silence

During each of the 20 sessions each subject was given his predetermined 81 addition problems to attempt within the 20-minute time period. Regardless of whether the subject was under contingent music or silence conditions he was told to wear the earphones while working the machine and that "sometimes he would hear music and sometimes he would not."

Under the 10-session contingent-music condition each subject obtained preferred "Motown Sound" (MTC 655) music immediately after pushing the key associated with the correct answer to the addition problem; the next problem was presented in .9 seconds. Each time a correct response obtained music, the duration of music presentation was extended up to, but did not exceed, the number of seconds of the subject's predetermined median IRT. If the subject did not solve each subsequent problem by pushing the correct key within his median IRT, music was terminated at the end of this median IRT. Music was immediately terminated (concurrent with the 3 sec black-out) each time the subject made an incorrect response. Following the 3-sec. termination of music, the computation which the subject had failed in the preceding trial was presented again. Music was obtained only after the subject pushed the key associated with the correct answer. Consequently, each subject obtained continuous music only if he pushed the correct key within his median IRT.

The presentation or termination of this music as a consequence was controlled electromechanically; the tape recorder producing "Motown Sound" was constantly in motion and was recorded so that one musical selection immediately followed the previous one. This eliminated the usual short pauses between songs that occurred on the original commercial recording, and was controlled by the subject's key-pushing responses.

Under the 10-session silence condition the tape recorder was turned off and the subject obtained no music at any time while pushing any of the four keys. Otherwise, all procedures were identical to the contingent music condition.

Experiment II

Contingent Music and Noncontingent Music

There was one change from the previous procedure in presentation of contingent music (CM) after errors had terminated the music. If the subject made an incorrect response, the same computation was presented again; however, music was not obtained after the subject pushed the correct key. This change in procedure allowed the subject to obtain music only if the correct key was pushed first after the problem was presented.

Under the 10-session noncontingent music condition, the tape recording producing "Motown Sound" was constantly in motion and each subject received uninterrupted music during each session. Correct and incorrect responding had no effect on music presentation.

Experiment III

Contingent Music and Contingent White Noise

The contingent music procedure was the same as in Experiment II. In the 10-session, contingent-white-noise condition each subject obtained white noise via the same procedure used for contingent music.

Measurement

The number of correct computations and the number of errors were counted for each session for all three experiments; an accuracy index (a.i.) was calculated for each subject daily by subtracting the number of errors from the number of correct computations and dividing this difference by the sum of errors plus correct computations (a.i. = $\frac{\text{correct - errors}}{\text{correct + errors}}$). This resulted in an a.i. that ranged from -1.00 if the subject made all errors, or +1.00 if the subject worked all problems correctly; if the subject made an equal number of errors and correct computations, his score was 0.00.

Results

As shown in Table 1, the study was designed to evaluate:

I. Order of presentation of contingent music
II. Trial blocks
III. Sessions
IV. Experiments
V. All interactions of the above factors

TABLE I

Design for three experiments with two orders of presentation of contingent music vs control conditions in Trial Block 1 and Trial Block 2 (N = 9 per experimental block)

Order of Presentation	Experiment	Subjects	Trial Block 1 (Sessions 1-10)	Trial Block 2 (Sessions 11-20)
Contingent music first	I	1 – 9	Contingent music	Control (silence)
	II	10 – 18	Contingent music	Control (noncontingent music)
	III	19 – 27	Contingent music	Control (contingent white noise)
Contingent music second	I	28 – 36	Control (silence)	Contingent music
	II	37 – 45	Control (noncontingent music)	Contingent music
	III	46 – 54	Control (contingent white noise)	Contingent music

Thus, the analysis of variance dealt with four main effects plus the interactions generated by these main variables. The interactions generated were six simple interactions, four double interactions, and a triple interaction. This model for analysis of variance was taken from Winer, (1962, p. 350). Two separate analyses were conducted: (1) addition computation rate, and (2) accuracy.

Addition Computation Rate

Five of the F values for addition computation rate were significant ($P < .05$):

1. Main effects for sessions within trial blocks
2. Main effects for trial blocks
3. Simple interaction for order of presentation X trial blocks
4. Double interaction for sessions X trial blocks X order of presentation
5. Double interaction for experiments X sessions X orders of presentation.

Of main concern was the simple interaction for order of presentation x trial blocks and the double interaction for sessions x trial blocks x order of presentation. Only these effects are discussed herein.

Order X trial block: This interaction effect indicates that the difference in computation rate between contingent music and control conditions was not the same during trial block 1 and trial block 2. During trial block 1, computation rate was similar under both contingent music and control conditions; however, during trial block 2, computation rate was greater for contingent music than under control conditions.

Order X trial blocks X sessions: This interaction means that computation rate differed over sessions within the trial blocks depending on the order of presentation of contingent music and control conditions. Figure 3 shows the effect of contingent music when it was presented during the first trial block followed by control conditions during the second trial block. During the first trial block (contingent music) the rate of responding increased from 3.4 computations per min (C/M) to 5.4 C/M. During the second trial block (control condition) the rate of responding increased only from 5.3 C/M to 5.9.

Figure 4 shows the effect of contingent music when it was presented during the second trial block preceded by the control conditions of the first trial block.

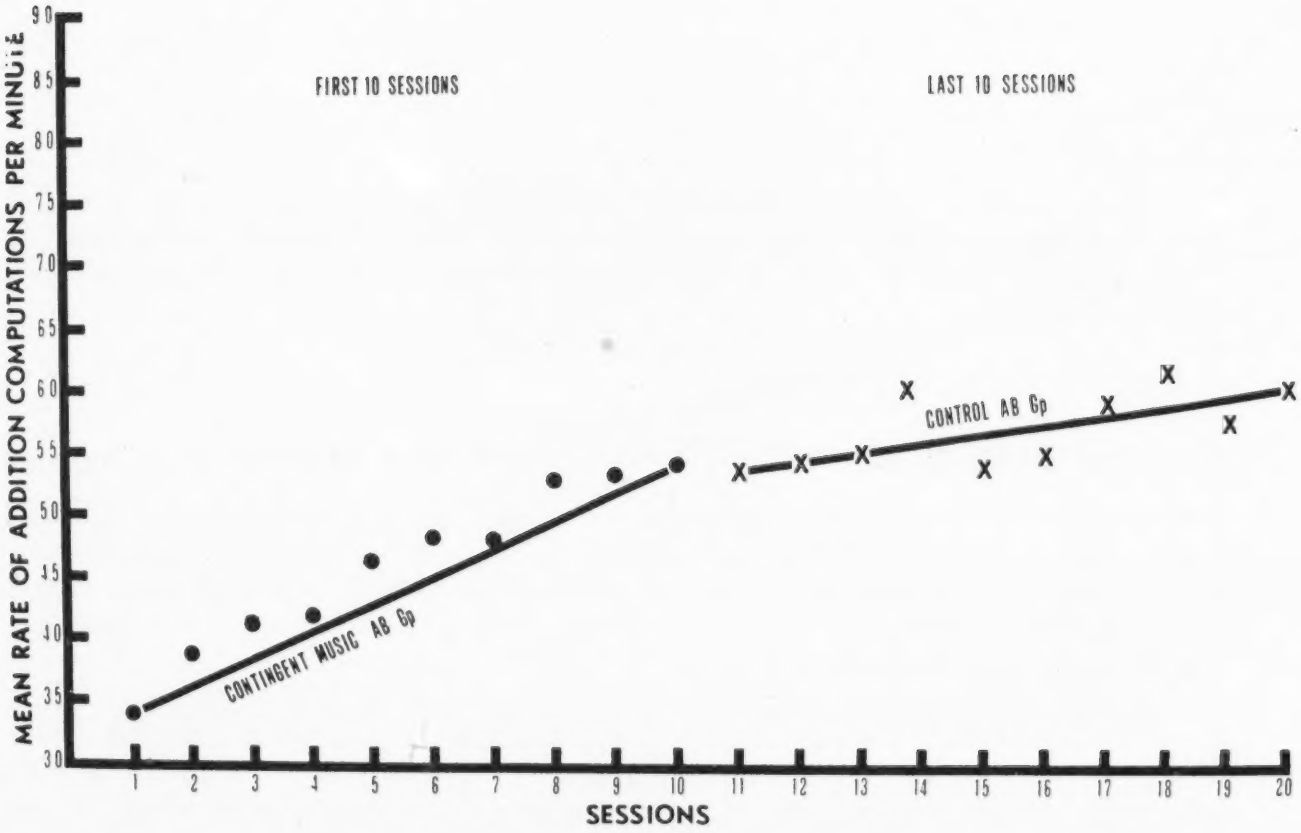

Figure 3. Mean rate of addition computations per minute for the AB group of subjects (N = 27) under contingent music conditions during the first 10 sessions and under control conditions during the last 10 sessions.

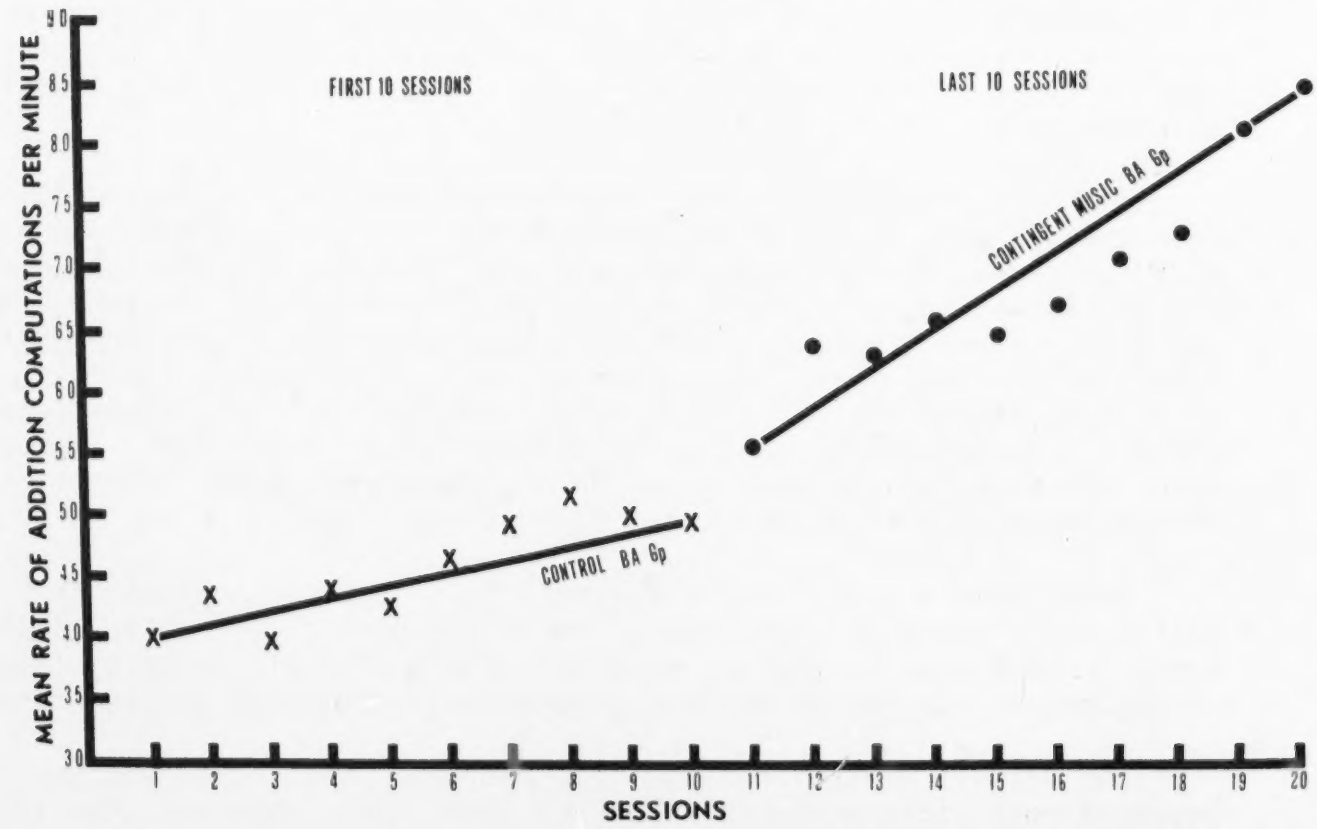

Figure 4. Mean rate of addition computation per minute for the BA group of subjects (N = 27) under control conditions during the first 10 sessions and under contingent music conditions during the last 10 sessions.

When control conditions were presented during the first trial block the increase was only from 4.1 C/M to 4.9 C/M. However, when contingent music was introduced during the second block, the rate increased from 5.5 C/M to 8.5 C/M.

Addition Computation Accuracy

The accuracy index $\frac{(\text{correct} - \text{errors})}{\text{correct} + \text{errors}}$ is a measure that indicates the proportion of correct computations out of the total computations attempted. For example, if the number of correct computations and errors during control conditions is 40 and 10, accuracy would be +0.60; and if, when contingent music is presented, the correct computations and errors increase to 80 and 20, accuracy would still be +0.60.

The analysis of variance of the accuracy scores indicated that none of the F values significant for computation rate were significant for accuracy. This means that higher computation rates generated by the order of contingent music presentation was not associated with an increase in error rate.

Discussion

Recent findings have indicated that contingent music reinforces simple motor responses, such as manual work tasks (Cotter, 1969). The present study indicates that preferred contingent music also increases the rate of working addition computations.

Addition computation rate increased over contingent-music sessions when the children obtained preferred music immediately after working an addition computation. There was a greater increase in computation rates per session during contingent music than during control sessions. This was true whether contingent music sessions preceded or followed control sessions. In comparison, computations per session during control conditions showed minimal increases in rate over sessions regardless of whether preceded or followed by contingent music conditions. The accuracy data indicate that the proportion of correct computations did not change during the higher rates generated by contingent music.

There were three types of controls built into the present investigation--silence, continuous music, and contingent white noise. Improvements in rate over trials was extremely limited in all three of these control conditions. This was especially true during the second ten sessions.

The results of the investigation indicate that contingent music increases response rate differently than control conditions. However, the fact that subjects given contingent music during the first ten sessions did not differ significantly from subjects who received the control condition raises some questions. An obvious explanation is the large amount of between-

subject variance. However, there is some indication that initially contingent music may have had a suppressing effect. Subjects on contingent music actually performed poorer than control subjects through the first five sessions. However, after the fifth session, contingent music subjects performed equal to or slightly better than control subjects. During the second ten sessions, contingent music subjects showed a marked improvement as compared to the control subjects.

While music has reinforcing properties, it also has other stimulus properties. Some of these may actually be incompatible with working complex problems as when addition rate and accuracy were suppressed in Cotter and Spradlin's (previous) noncontingent music study. For example, some subjects sang or attempted to keep time to the music. These responses probably interfered with rapid and accurate performance on an addition-type task. The music used in this study had demonstrable reinforcing properties. However, since it was predominantly rhythmical and vocal, it may have had interfering properties that other music might not have. Although slower instrumental music might be less preferred, it still might result in more rapid and accurate addition performance because it may not interfere as vocal music does.

Music may also have pacing characteristics. This aspect of music was partially controlled for by the inclusion of the contingent white noise control. However, one must recognize the possible difference between a reinforcing pacer (contingent music) and an aversive pacer (contingent white noise).

Although the present study suggests that contingent music increases rate of solving addition problems, additional studies will be required to determine exactly what function music has and how to use it most effectively to facilitate performance on a teaching machine-type task.

References

Azrin, N. H. Some effects of noise on human behavior. Journal of Experimental Analysis of Behavior, 1958, 1, 183-200.

Barrett, B. H. Reduction in rate of multiple tics by free operant conditioning methods. Journal of Nervous and Mental Disease, 1962, 135, 187-195.

Cotter, V. W., & Toombs, S. A procedure for determining the music preferences of mental retardates. Journal of Music Therapy, 1966, 3, 57-64.

Cotter, V. W. Effects of music on retarded girls' performance of manual tasks. Dissertation Abstracts, 1969.

Cotter, V. W., & Spradlin, J. E. A nonverbal technique for studying music preference. Journal of Experimental Child Psychology, in press.

Jeffry, W. E. A new technique for motivating and reinforcing children. Science, 1955, 121, 371.

Morgan, B. M., & Lindsley, O. R. Operant preference for stereophonic over monophonic music. Journal of Music Therapy, 1963, 3, 135-143.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

END

DEPT.OF HEALTH EDUCATION AND WELFARE

U.S. OFFICE OF EDUCATION

ERIC

DATE FILMED

4 7 72